Digital Image Processing (CSE/ECE 478)
Monsoon-2019
Assignment-1 (200 points)
Posted on: 07/08/19
Due on: 17/08/19

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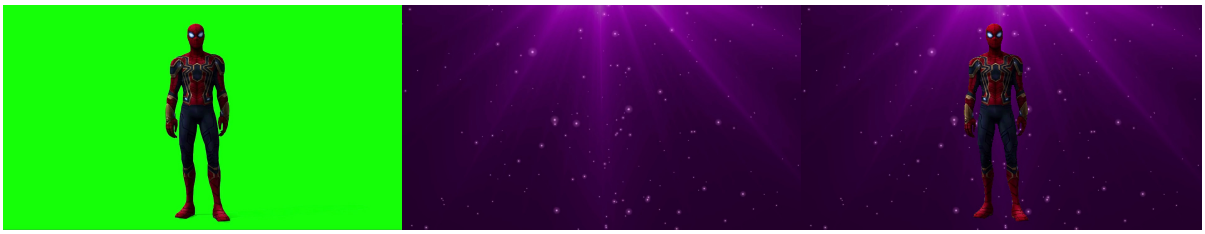
1. (30 points) Pixel Manipulation
    1. Write a function that takes a color image and finds the most frequently occurring color from the image. (10 points)
    2. Write a function `mergeImage` which takes two images `fg` and `bg` that extracts the foreground object and places it in the background and returns the resultant image. (15 points)
    3. Try out with different foreground and background images of your choice and show the results. (5 points)



(a) foreground image (b) background image (c) result

2. (15 points) Contrast Stretching
    1. Write a function `linContrastStretching` which takes a grayscale image `im`, `a` and `b` that enhances the contrast such that the resulting intensity range is $[a, b]$. (5 points)
    2. Display the input image and the resultant image side-by-side along with their `colorbars` (a strip containing k most frequently occurring colors). Give suitable explanation for the resulting `colorbars`. (5 points)
    3. Use your function on multiple images and argue why the effect is more on some images while it is not that apparent on the others. (5 points)

3. (30 points) Bits Manipulation

    1. Write a function `BitQuantizeImage` which takes an 8-bit image `im` and `k`, the number of bits to which the image needs to be quantized to and returns the k-bit quantized image. Display results for the image *quantize.jpg* (10 points)
    2. Write a code to display different bit planes of an 8-bit gray-scale image. Display results for the image *cameraman.png* (5 points)
    3. Given original image *lena.jpg* identify the operations applied on the images *lena1.jpg*, *lena2.jpg* and *lena3.jpg*. (15 points)

(a) lena.jpg

(b) lena1.jpg

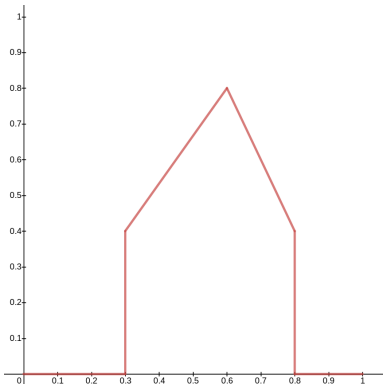
(a) lena2.jpg

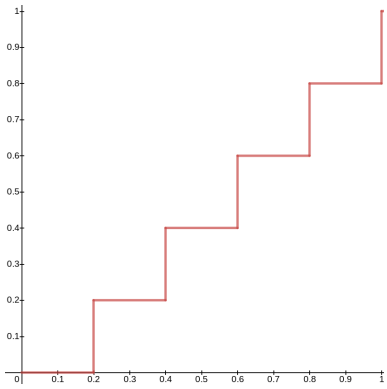
(b) lena3.jpg

4. (40 points) Intensity Transformation

    1. Write a function to create the negative of an image. The function should take the image and maximum intensity as arguments. Produce the transformed output for first 8 k-bit quantized forms of *lena.jpg*. (10 points)
    2. Using the image *gamma-corr.png*, apply the Gamma Transform $s = r^{\gamma}$ and vary γ. Report your observations. (15 points)
    3. Write a function to implement a piecewise linear transform $g(z) = K_1^i \cdot z + K_2^i$; $a^i \leq z \leq b^i$. The function takes an input image, coefficients K1,K2 and intervals

a,b for each linear segment and produces the transformed output image. Produced transformed outputs of *lena.jpg* for the following functions: (15 points)





5. (20 points) Miscellaneous

    1. What can you say about the histogram of a resulting image if we keep the MSB bits in the bitplane to 0? (5 points)
    2. What can you say about the histogram of a resulting image if we keep the LSB bits in the bitplane to 0? (5 points)
    3. Transmission is usually achieved through packets containing a start bit, a byte of information and a stop bit. Baud rate is a common measure for digital data transmission and is defined as number of bits transmitted per second. How much time would it take to transmit 512 x 512 grayscale image with intensity 0-255 over a 56K baud link? Similarly, calculate the time required to transmit the same image over a 3000K baud link. (10 points)

6. (35 points) Histogram Equalization and Matching

    1. Write a function `histEqualization` which takes a grayscale image `im`, and applies histogram equalization on the entire image. (10 points)
    2. Display the input image and the resultant image side-by-side and provide suitable explanation for the changes you observe for multiple input images. (5 points)
    3. Write a function `histMatching` which takes an input image and a reference image and applies histogram Matching on the input image by matching the histogram with that of the reference image. Use `eye.png` and `eyeref.png` (converted to grayscale) as the input and reference images respectively. (10 points)
    4. You are provided with 4 images (`part1.png`, `part2.png`, `part3.png`, `part4.png`) with different contrast levels which correspond to four quadrants of `canyon.png` as shown in Figure 5. Retrieve the original image(converted to grayscale) using these four images(converted to grayscale) as closely as possible. (10 points)

7. (30 points) Histogram Transformation

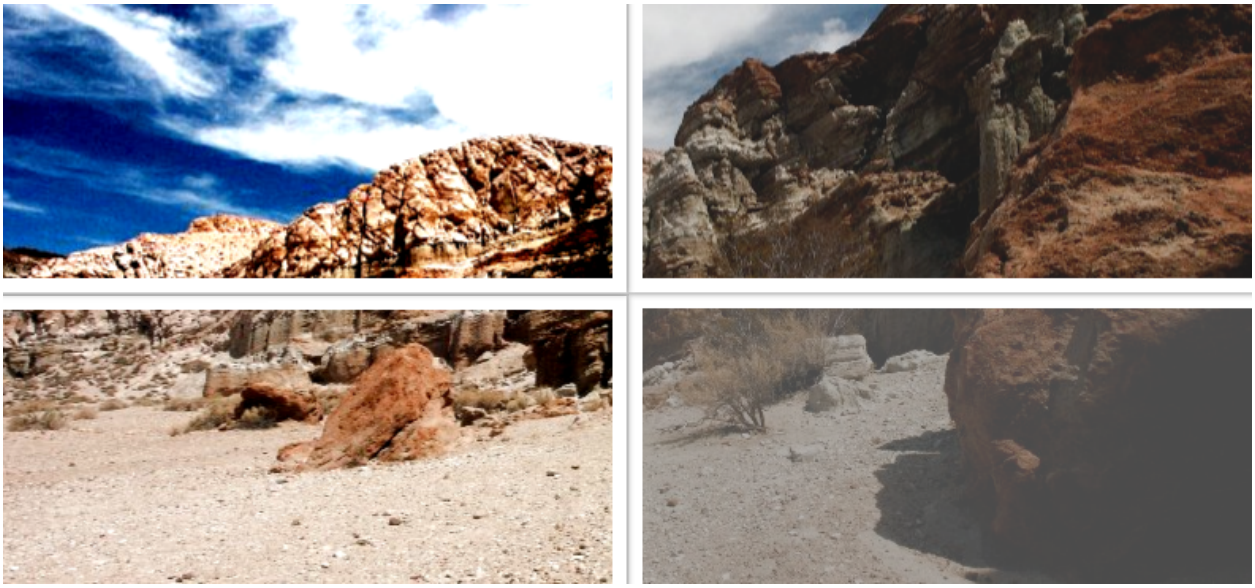


Figure 5: Four quadrants with different contrast levels

1. Choose an image of your choice and apply histogram equalization to it. Apply histogram equalization to the resulting image and compare the two images. What are your observations? (10 points)
2. Pick the following combination of images and perform histogram transformation on them.(20 points)
   - Similar Histograms
   - Dark →Light Image
   - Light →Dark Image